

ECE 440 - Introduction to Computer Networks

Spring 2020
Lecture I

Chapter 1: roadmap

1.1 *what is the Internet?*

1.2 network edge

- end systems, access networks, links

1.3 network core

- packet switching, circuit switching, network structure

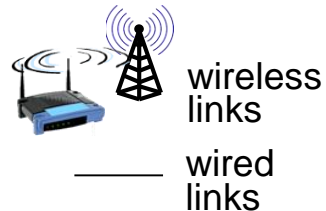
1.4 delay, loss, throughput in networks

1.5 protocol layers, service models

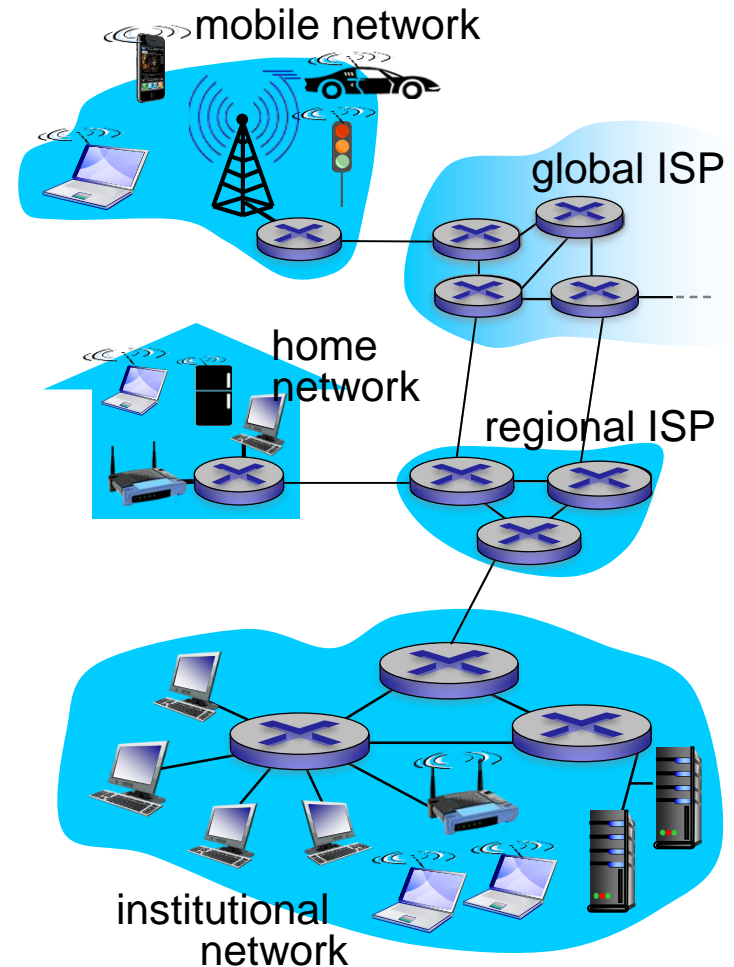
1.6 networks under attack: security

1.7 history

What's the Internet: “nuts and bolts” view



- billions of connected computing devices:
 - *hosts* = *end systems*
 - running *network apps*
- *communication links*
 - fiber, copper, radio, satellite
 - transmission rate: *bandwidth*
- *packet switches*: forward packets (chunks of data)
 - *routers* and *switches*



“Fun” Internet-connected devices



IP picture frame
<http://www.ceiva.com/>



Web-enabled toaster +
weather forecaster



Tweet-a-watt:
monitor energy use



Internet
refrigerator



Slingbox: watch,
control cable TV remotely



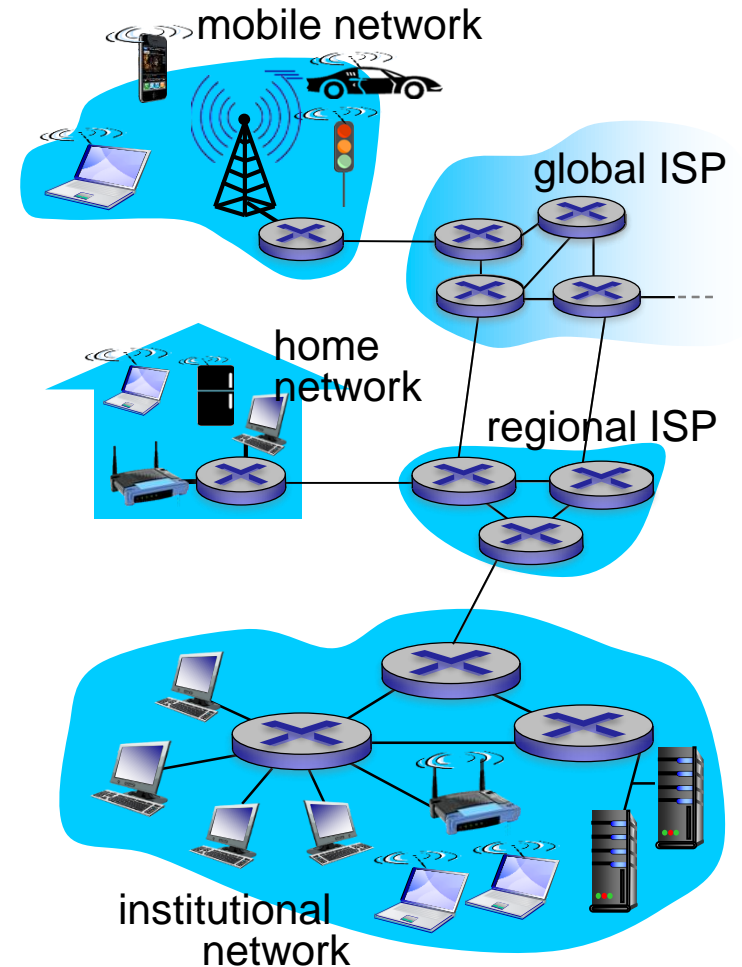
sensorized,
bed
mattress



Internet phones

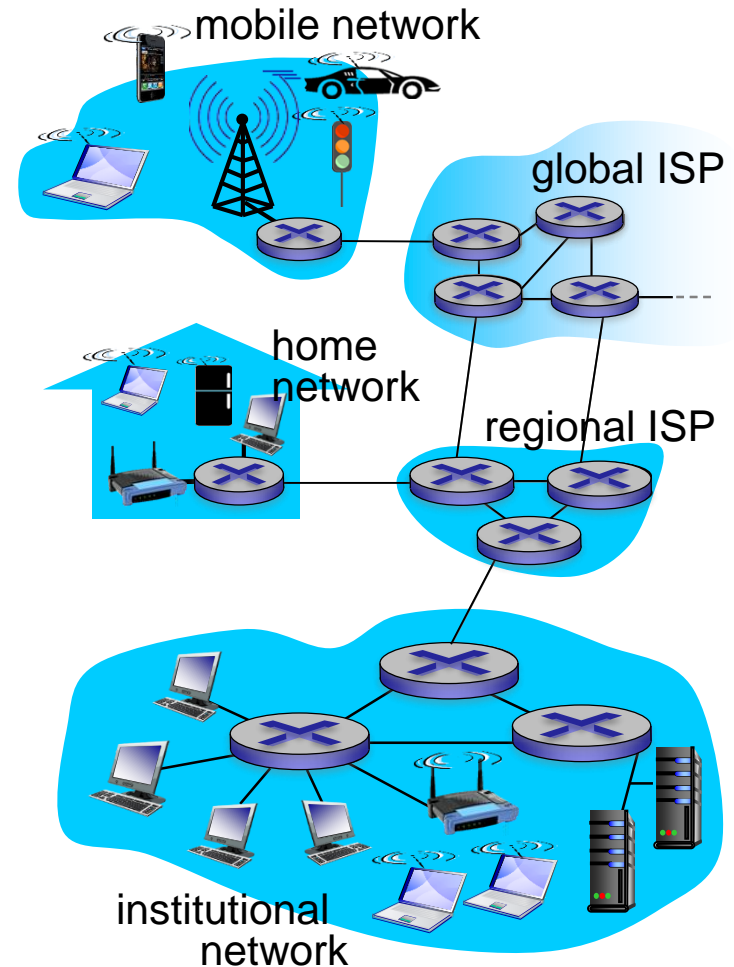
What's the Internet: “nuts and bolts” view

- **Internet: “network of networks”**
 - Interconnected ISPs
- **protocols** control sending, receiving of messages
 - e.g., TCP, IP, HTTP, Skype, 802.11
- **Internet standards**
 - RFC: Request for comments
 - IETF: Internet Engineering Task Force



What's the Internet: a service view

- *infrastructure that provides services to applications:*
 - Web, VoIP, email, games, e-commerce, social nets, ...
- *provides programming interface to apps*
 - hooks that allow sending and receiving app programs to “connect” to Internet
 - provides service options, analogous to postal service



What's a protocol?

human protocols:

- “what's the time?”
- “I have a question”
- introductions

... specific messages sent

... specific actions taken
when messages
received, or other
events

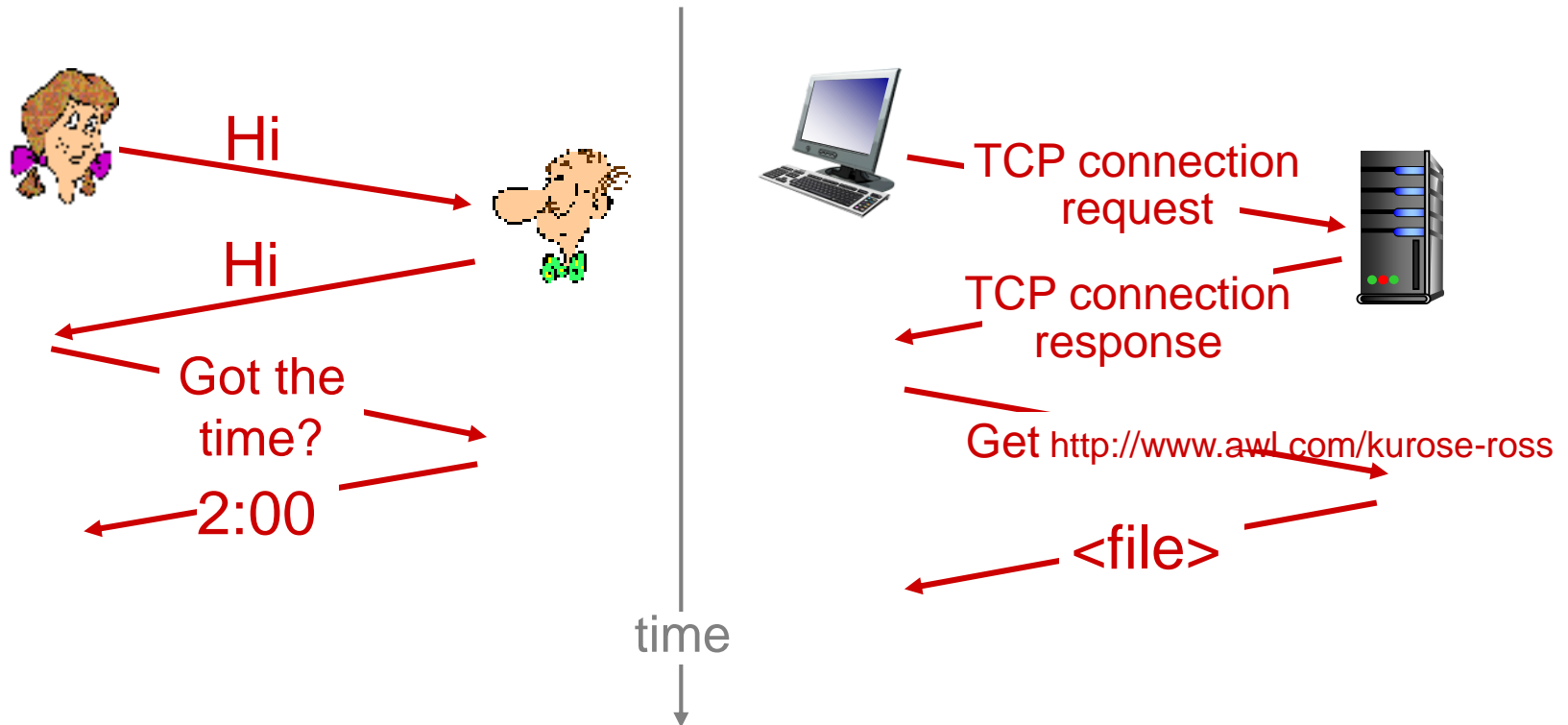
network protocols:

- machines rather than humans
- all communication activity in Internet governed by protocols

protocols define format, order of messages sent and received among network entities, and actions taken on message transmission, receipt

What's a protocol?

a human protocol and a computer network protocol:



Q: other human protocols?

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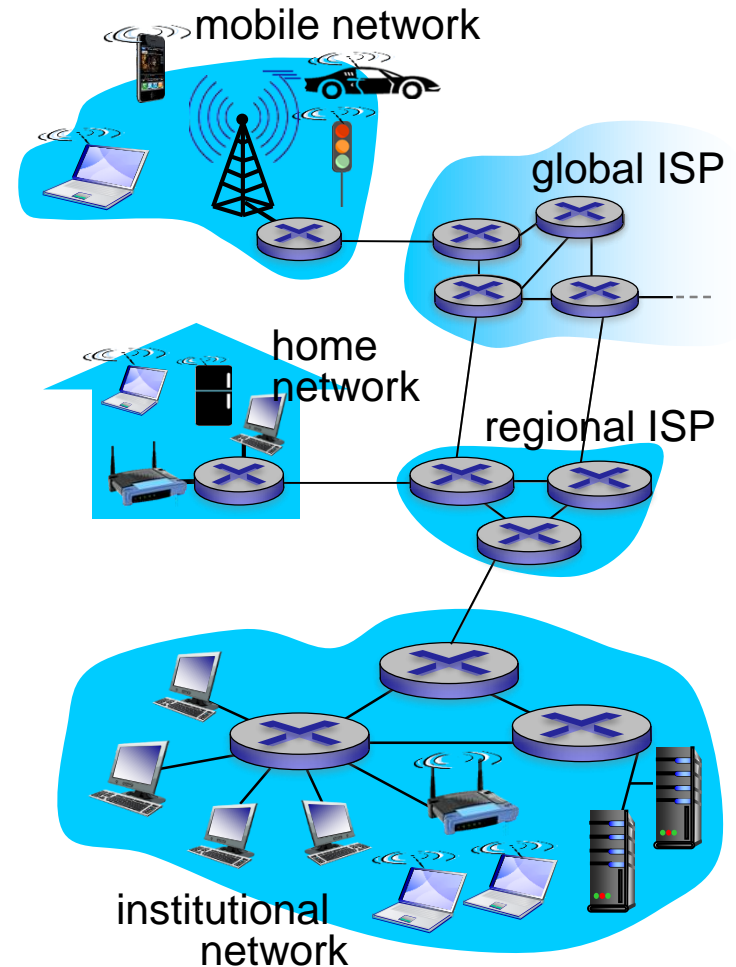
1.5 protocol layers, service models

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A closer look at network structure:

- *network edge:*
 - hosts: clients and servers
 - servers often in data centers
- *access networks, physical media:* wired, wireless communication links
- *network core:*
 - interconnected routers
 - network of networks



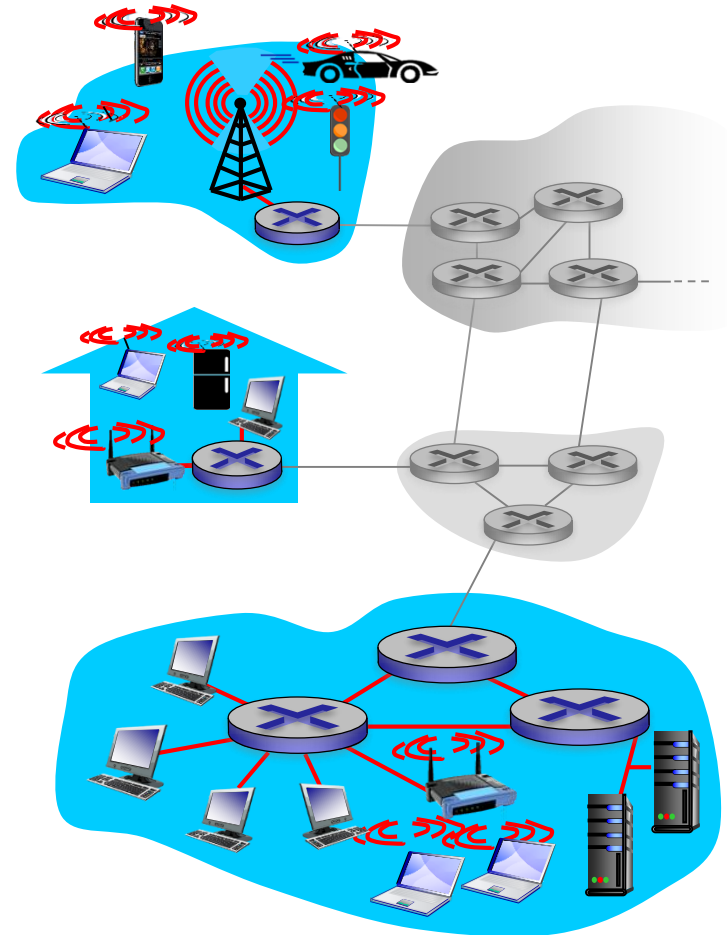
Access networks and physical media

Q: How to connect end systems to edge router?

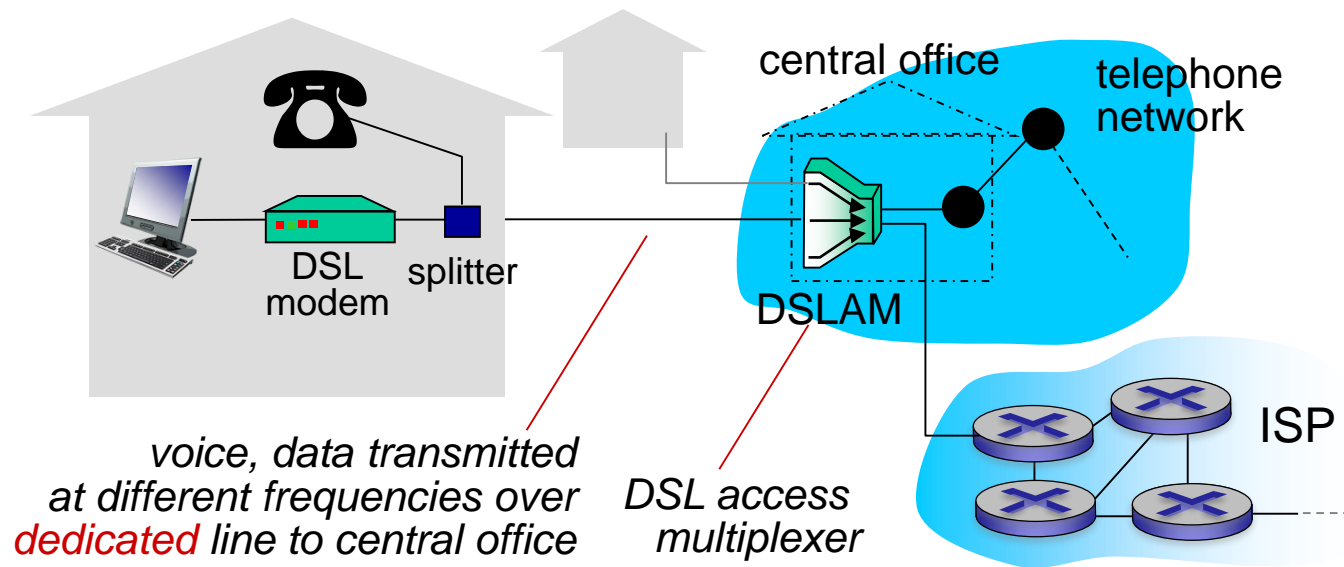
- residential access nets
- institutional access networks (school, company)
- mobile access networks

keep in mind:

- bandwidth (bits per second) of access network?
- shared or dedicated?

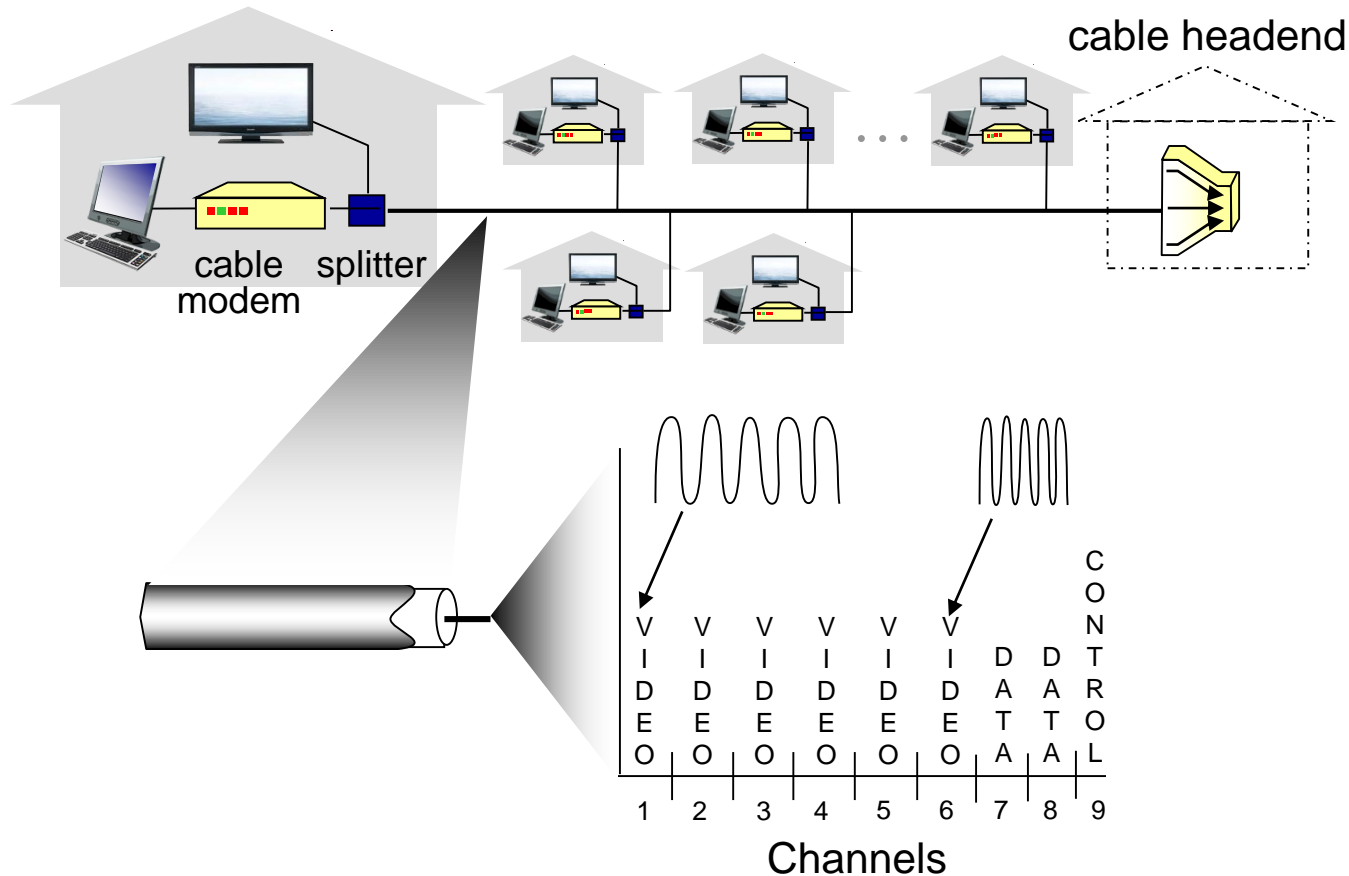


Access network: digital subscriber line (DSL)



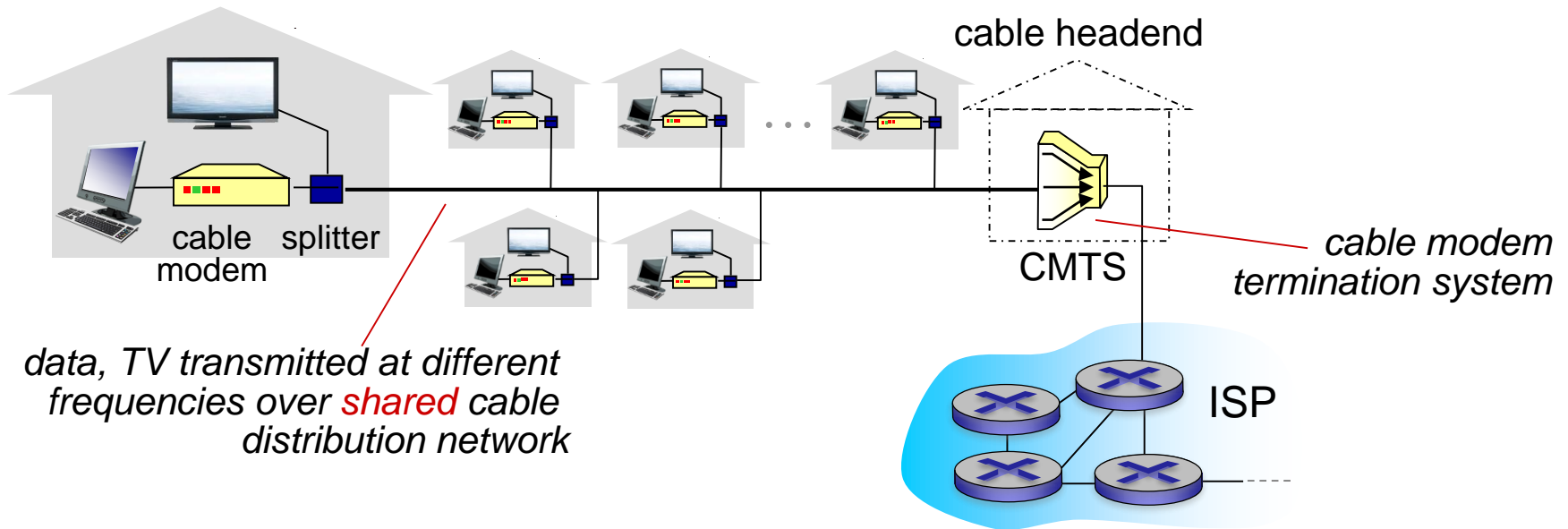
- use *existing* telephone line to central office DSLAM
 - data over DSL phone line goes to Internet
 - voice over DSL phone line goes to telephone net
- < 2.5 Mbps upstream transmission rate (typically < 1 Mbps)
- < 24 Mbps downstream transmission rate (typically < 10 Mbps)

Access network: cable network



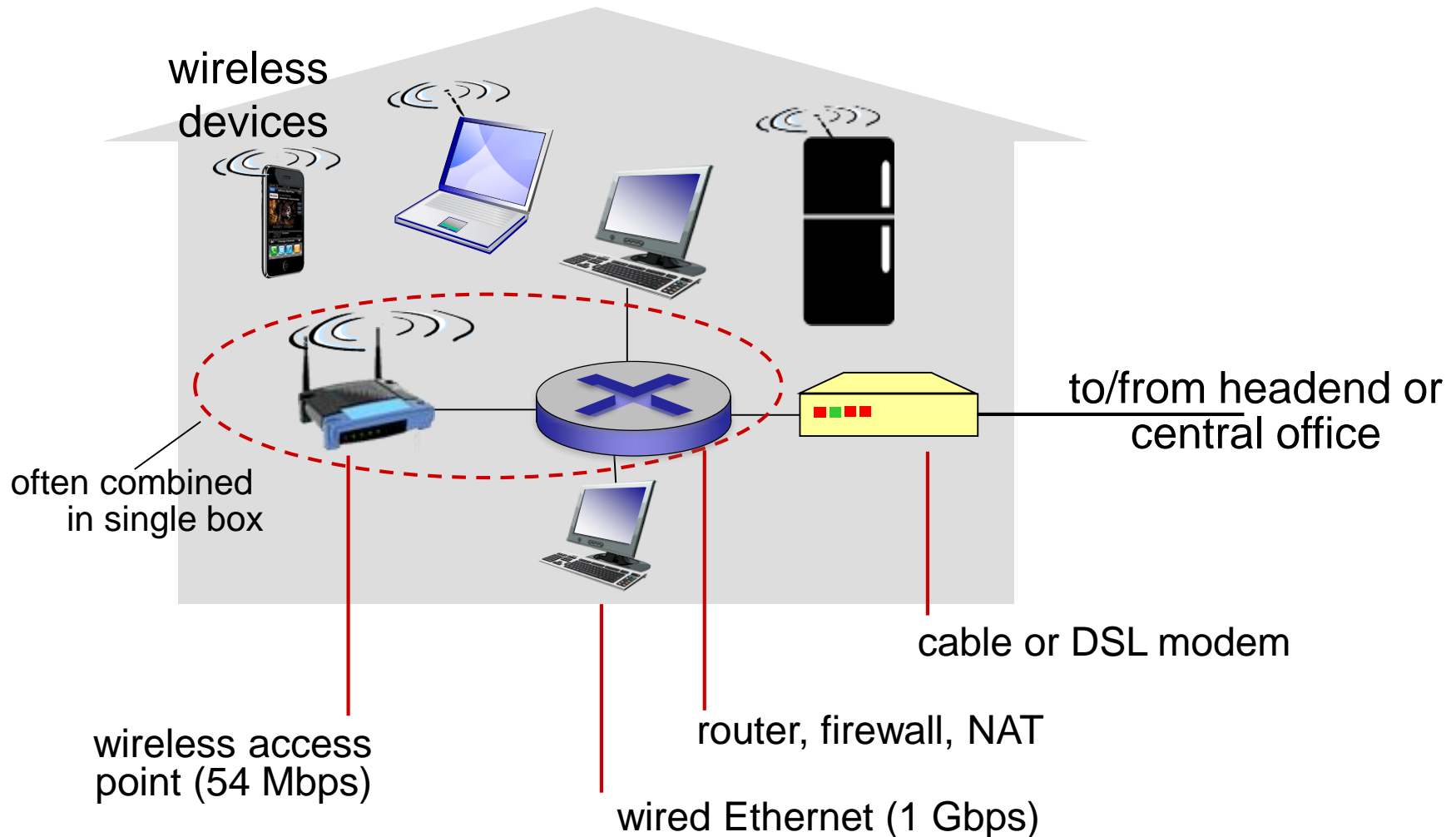
frequency division multiplexing: different channels transmitted in different frequency bands

Access network: cable network

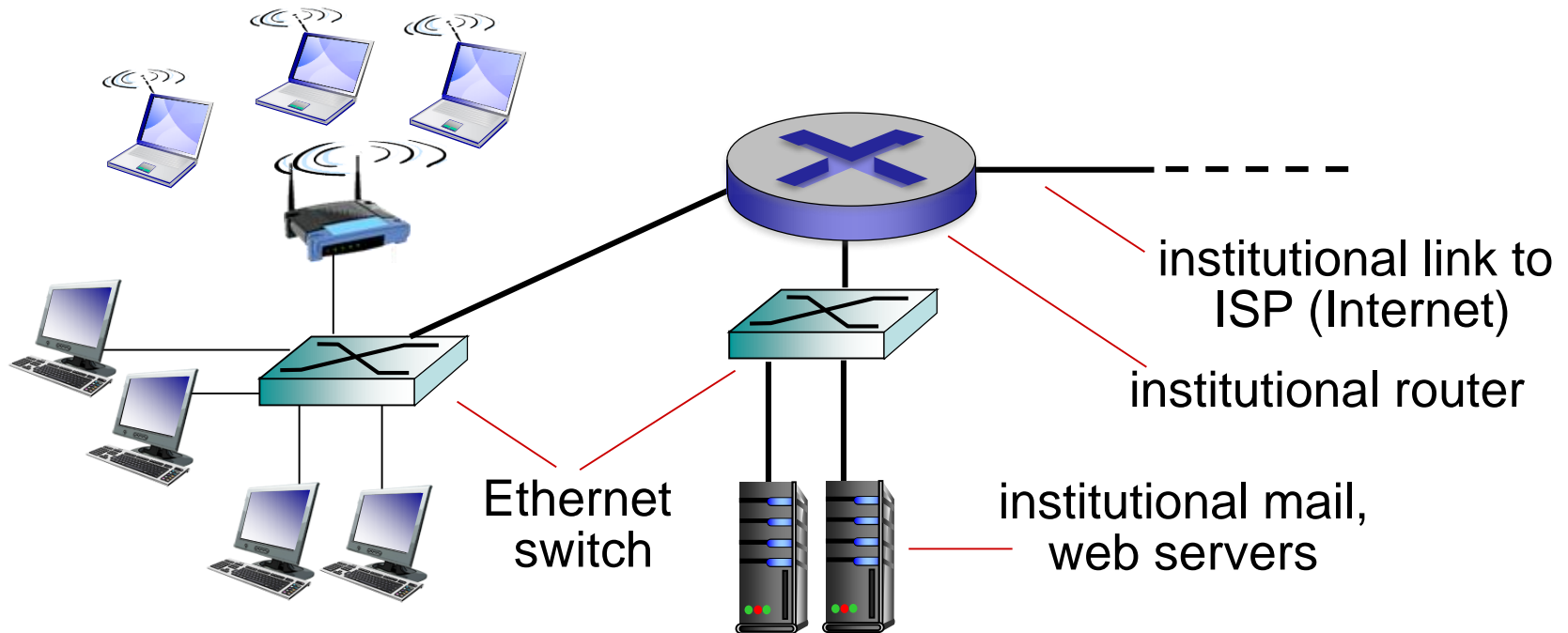


- **HFC: hybrid fiber coax**
 - asymmetric: up to 30Mbps downstream transmission rate, 2 Mbps upstream transmission rate
- **network** of cable, fiber attaches homes to ISP router
 - homes *share access network* to cable headend
 - unlike DSL, which has dedicated access to central office

Access network: home network



Enterprise access networks (Ethernet)



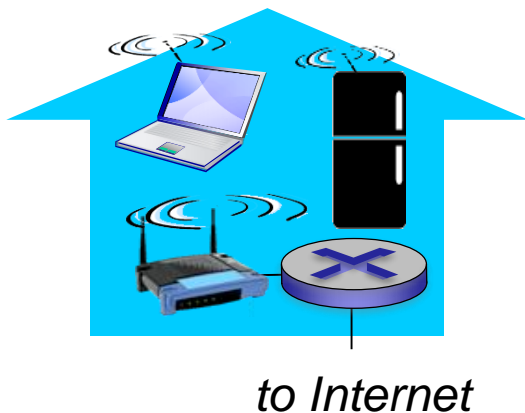
- typically used in companies, universities, etc.
- 10 Mbps, 100Mbps, 1Gbps, 10Gbps transmission rates
- today, end systems typically connect into Ethernet switch

Wireless access networks

- shared *wireless* access network connects end system to router
 - via base station aka “access point”

wireless LANs:

- within building (100 ft.)
- 802.11b/g/n (WiFi): 11, 54, 450 Mbps transmission rate



wide-area wireless access

- provided by telco (cellular) operator, 10's km
- between 1 and 10 Mbps
- 3G, 4G: LTE

